

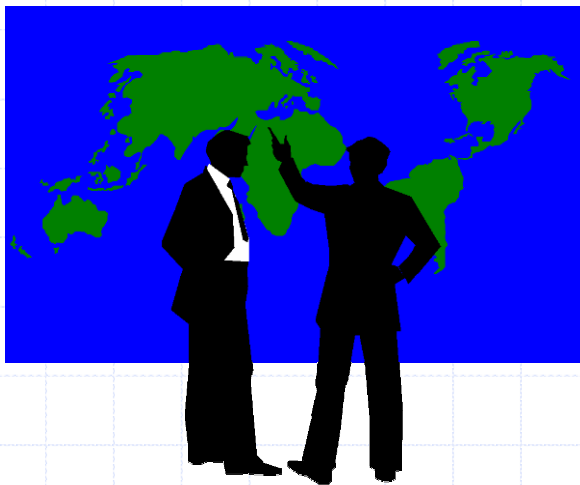


U.S. Department of Energy

OAK RIDGE NATIONAL LABORATORY

CHP Subcontractors Coordination Review Meeting

*Enhancement to Distributed Generation
Operational Reliability Database
Large CHP Market Analysis*



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Name of Contract and Subcontractors

Energy & Environmental Analysis, Inc.

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Description of Task(s)

- § Enhancements to Distributed Generation/Combined Heat & Power Operational Reliability and Availability Database
- § Large CHP Market Analysis

Task 1 DG/CHP Operational Reliability Database

- § Enhancements to Distributed Generation/Combined Heat & Power Operational Reliability and Availability Database
 - § Create DG/CHP OR DB version 2.0 with additional units - >120 total units
 - § Consistent with established industry standards
 - § Includes operational and operating data over a two year period
 - § 731 MW of capacity
 - § 2,991 outage events
 - § 1,669,411 unit-hours of operation
 - § Includes users in commercial, institutional and industrial sectors

Task 1 DG/CHP OR Database

- § Establish baseline operating and reliability data for industrial and commercial distributed generation and combined heat and power systems
 - § DG/CHP system reliability and availability is a critical element in market development
 - § AF, FOR, SOF, SF, MTBFO, MDT
- § Data from maintenance logs, operation records, and other available sources
 - § Exhaustive collection of data from a sample of operating facilities
 - § Methodology is based on industry standard definitions and actual customer data
 - § Dependent on customer participation
 - § Leverages substantial prior work by others on evaluating onsite power system reliability
- § Identify and classify DG/CHP system failures and outages

Task 2 Large CHP Market Analysis

- § Perform market assessment of large (>2-50 MW) CHP market in industrial, institutional, and commercial sectors
- § Utilize latest Major Industrial Plant Database (MIPD) and Commercial Energy Profile Database (CEPD)
 - § 18,000+ industrial and 150,000+ commercial facilities
- § Use thermal and electrical data to analyze opportunities for simple cycle gas turbines, recuperated gas turbines, and reciprocating engines
- § Identify near-term market opportunities in this size range
 - § Segment by state, SIC, and technology
 - § Characterization profiles for selected sectors
 - § Help target outreach to key segments with greatest economic potential

Task 2 Large CHP Market Analysis - Methodology

§ Five technologies

- § Conventional Reciprocating Engine (1 MW)
- § Advanced Reciprocating Engine (3 MW)
- § Conventional Industrial Gas Turbine (5 MW)
- § Conventional Industrial Gas Turbine (10 MW)
- § Advanced Recuperated Gas Turbine (4.2 MW)

§ EEA Technology Characterizations used for cost and performance assumptions

§ Economic Screening

- § Calculate net cost of electricity (COE) for each technology class
 - § Credit for heat recovery
- § Identify sites whose current COE was equal or greater than calculated net COE
- § Identify sites whose current COE would allow for a 5 year or less simple payback

§ Identify and profile sectors of interest

Progress Against Tasks and Milestones

§ Task 1: DG/CHP OR Database Enhancements

- § 9 month project
- § Contact screened participant sites - *completed*
- § Data review and entry - *completed*
- § Calculate OR measures - *completed*
- § System Forced Outage Analysis - *completed*
- § Report and DG/CHP OR DB Version 2.0 - *completed*

§ Task 2: Large CHP Market Analysis

- § 8 month project
- § Procure MIPD and partial CEPD - *completed*
- § Finalize market screening criteria - *completed*
- § Data analysis - *completed*
- § Sector profiles - *completed*

Summary of Key Results and Conclusions

§ Task 1: DG/CHP OR Database Enhancements

Technology Group	n	AF (%) Avg.	FOR (%) Avg.	SOF (%) Avg.	SF (%) Avg.	MTBFO (hrs) Avg.	MDT (hrs) Avg.
<100 kW RE	14	97.83	1.76	0.73	75.11	784.75	13.71
100-800 kW RE	8	95.99	1.98	2.47	51.76	1352.26	50.66
>800 kW RE	18	98.22	0.85	1.12	40.59	3582.77	27.06
<200 kW FC	15	76.84	22.94	0.92	74.01	2004.47	369.24
0.5-3 MW GT	11	97.13	2.89	0.99	57.93	2219.72	65.38
3-20 MW GT	21	94.97	2.88	2.39	82.24	1956.46	68.63
20-100 MW GT	9	93.53	1.37	5.14	88.74	3604.62	75.30
<25 MW ST	25	92.02	2.34	6.01	81.12	5317.73	292.06
Entire Sample	121	93.09	4.65	2.66	70.23	2869.83	138.53

Fuel Cell sample was part of a demonstration program of newly commercial technologies. Availability was greatly affected by downtime associated with unusually long delays associated with demonstrations and not related to typical operation.

Fuel Cell OR performance validated decision not to include Microturbines as units with high operating hours were demos and pre-commercial units

Large Reciprocating Engine performance was much better than expected.

Summary of Key Results and Conclusions

§ Task 1: DG/CHP OR Database Enhancements

- § Specific units were observed to exhibit both very good to poor OR performance
- § In almost all technology groups, subsystems other than the prime movers themselves contributed more significantly to the occurrence of forced outage events
- § Many events that occurred were the result of random equipment failures expected of any complex power system.
- § This project did not result in the identification of any systemic problems
 - § Most failures within technology groups appear to be random occurrences of short duration
- § Version 2.0 enhances the framework for recording operating data and analyzing OR performance
- § Calculated performances of Fuel Cell systems illustrates need to keep established and emerging technologies distinct
- § Large reciprocating engine performance was notably better than expected

Summary of Key Results and Conclusions

§ Task 1: DG/CHP OR Database Enhancements

§ Potential Follow-up

- § Add additional units in under-represented technology groups to improve the robustness of the data
- § Include microturbines with at least two years of operations (not including R&D demonstration) along with fuel cells with similar operating history in a separate database pertaining to emerging DG/CHP technologies
- § Update data on an annual basis to include years of operation beyond the original period
- § Any follow-up effort needs an efficient site identification and data collection process.
 - § E.g., monthly data submission by site operators with secure web-based data entry system would reduce the labor costs associated with data collection substantially

Summary of Key Results and Conclusions

§ Task 2: Large CHP Market Assessment

§ Sample Net COE based on 6000 hrs and \$6 gas

	Rec. GT (4.2 MW)	Con. GT (5 MW)	Con. GT (10 MW)	Con. RE (1 MW)	Adv. RE (3 MW)
COE (\$/kWh)	0.08563	0.10921	0.10131	0.09470	0.09206
Thermal Credit (\$/kWh)	0.01964	0.0375	0.03487	0.02775	0.0246
Net COE (\$/kWh)	0.06599	0.07171	0.06644	0.06695	0.06746

Summary of Key Results and Conclusions

§ Task 2: Large CHP Market Assessment

§ Number of Potential CHP Sites Screened by Net COE

		4.2MW Recup GT	5MW GT	10MW GT	1MW Recip Engine	3MW ARES
SIC2		1	2	3	4	5
Industrial	20 Food & Kindred Products	23	16	5	42	30
	22 Textile Mill Products	4	1	0	7	4
	24 Lumber & Wood Products	4	0	2	7	4
	26 Paper & Allied Products	33	18	17	49	36
	27 Printing & Publishing	0	0	0	2	0
	28 Chemicals & Allied Products	37	28	17	61	39
	29 Petroleum & Coal Products	8	6	5	13	9
	30 Rubber & Misc. Plastic Prods.	6	4	3	12	6
	32 Stone, Clay & Glass Prods.	3	3	3	7	4
	33 Primary Metal Industries	8	5	5	15	11
	34 Fabricated Metal Products	4	2	2	7	6
	35 Machinery & Computer Equip	7	6	3	12	8
	36 Electric & Electronic Equip	5	3	2	9	7
	37 Transportation Equip	9	7	5	12	10
	38 Instruments & Related Prods	4	0	1	5	4
	39 Misc. Manufacturing Industries	2	1	0	2	2
Commercial	51 Wholesale Trade -Nondurable Goods	0	0	0	1	1
	52 Bldg Materials, Hardware, Garden Sup.	0	0	0	2	0
	54 Food Stores	31	15	0	345	82
	70 Hotels, Rooming Houses, Lodging	31	24	0	123	63
	78 Motion Pictures	0	0	0	1	0
	80 Health Services	259	153	53	541	369
	82 Educational Services	59	27	13	184	108
	92 Justice, Public Order, and Safety	8	6	1	34	16
Total Sites		545	325	137	1493	819

Totals across technologies are not additive

Summary of Key Results and Conclusions

§ Task 2: Large CHP Market Assessment

- § Reduction in number economically viable sites with a slight change in economic threshold underscores that many potential projects are “on the bubble”
- § Modest reductions in costs (operating or installed) or new additional value can open substantial markets

	4.2MWRec. GT			5MWGT			10MWGT			1MWRecip			3MWARES		
Economic Screen	Sites	Units	Capacity (MW)	Sites	Units	Capacity (MW)	Sites	Units	Capacity (MW)	Sites	Units	Capacity (MW)	Sites	Units	Capacity (MW)
Net COE	545	947	3977	325	537	2685	137	174	1740	1493	6688	6688	819	1529	4587
5 Year Simple Payback	394	668	2932	208	333	1665	103	139	1390	1062	4800	4800	582	1120	3360
%Difference	27.7%	26.3%	26.3%	36.0%	38.0%	38.0%	24.8%	20.1%	20.1%	28.9%	28.2%	28.2%	28.9%	26.7%	26.7%

Summary of Key Results and Conclusions

§ Task 2: Large CHP Market Assessment

- § Screening results only as accurate as the information in the database
- § Economic viability is based solely on COE and does not consider other value streams that may be customer or site specific
- § Methodology did not consider export of electricity

Large CHP Sector Profiles

- § Market assessment concluded opportunities for CHP in the 2-50 MW size range remain and market is far from fully saturated.
- § Three sectors were identified as promising sectors identified at the conclusion of market assessment.
 - § Chemicals
 - § Food
 - § Pharmaceuticals
- § The profiles briefly characterize size of sector, industry trends, energy typical plant size and energy usage, historical use of CHP, growth trends, purchasing trends, geographic concentration, and potential.
- § The profiles are intended to help those developing CHP projects better understand the needs and drivers of customers in these sectors.

Large CHP Sector Profiles

- § All sectors have varying levels experience in CHP.
 - § Chemical sector in particular is comprised of very sophisticated energy users.
 - § Opportunities for non-steam CHP exist, e.g., fluid heating in the chemical sector.
- § Recent energy price increases and natural gas price volatility are very important issues.
 - § Many sites that have the potential to fuel switch.
 - § Potential utilization of biomass in Food sector.
- § Reliability of electric service is a growing concern.

Deliverables and Availability

§ Task 1: DG/CHP OR Database Enhancements

- § Version 2.0 of DG/CHP OR Database

- § CD

- § Final Report

- § CD

§ Task 2: Large CHP Market Analysis

- § Confidential Mid-Project Report

- § Public Executive Summary

- § CD

- § Sector Profiles (Chemical, Pharmaceutical, Food Processing)

- § CD

Coordination with Stakeholder Groups and Other Project Teams

§ Task 1: DG/CHP OR Database Enhancements

- § CHP user participation critical
- § Manufacturers, Packagers, and Developers
- § Industry Associations
- § Project Partners
 - § NYSERDA, Energy Solutions Center, GTI, DOD ERDC/CERL
- § Follow-up and Users
 - § SRI/ASERTTI, NYSERDA

§ Task 2: Large CHP Market Analysis

- § Solar Turbines
- § USCHPA/Sentech Industry Associations Outreach Project
- § Application Centers

Questions?

- § Enhancements to Distributed Generation/Combined Heat & Power Operational Reliability and Availability Database
- § Large CHP Market Analysis